

**WELDING FLUX FOR USE IN ARC-WELDING OF STAINLESS  
STEELS, METHOD OF WELDING STAINLESS STEEL  
MEMBERS USING THE WELDING FLUX**

**BACKGROUND OF THE INVENTION**

**5 1. Field of the Invention**

The present invention relates to arc-welding and more specifically, to a welding flux for use in arc-welding of stainless steels.

**2. Description of the Related Art**

When joining stainless steel parts using arc-welding, a wide and shadow  
10 molten cavity will be seen in the stainless steel parts during welding, therefore a better welding effect can be achieved only when the thickness of the weld thickness is controlled below 3mm. When going to joint thick stainless steel parts using arc-welding, for example, when welding a butt joint, a V-groove is made at the butt joint to shorten the weld thickness, and then welding the stainless steel parts through  
15 multiple welding procedures. This welding method wastes much time, thereby increasing the cost of the operation.

In 1960, PWI (Paton Welding Institute) disclosed a flux for arc-welding to increase the depth of weld pass penetration up to 5mm. However, because the fluoride content produces a harmful gas to human beings during welding, this flux is not  
20 acceptable to most users. In 1996, EWI (Edison Welding Institute) developed an easy way to apply flux for increasing the penetration of gas tungsten arc-welding of stainless steel under US Patent No. 5,804,792. The flux essentially consists of reagent or laboratory grade TiO or TiO<sub>2</sub> (about 50%), Cr<sub>2</sub>O<sub>3</sub> (about 40%), and SiO<sub>2</sub> (about 10%) in a liquid carrier, preferably of methyl ethyl ketone. The flux is easy to apply,  
25 increases penetration of the weld up to 5mm. However, this composition of flux still

has drawbacks. When examined the cross section of the weld pass of, for example, a butt joint, the cross section exhibited a relatively narrow middle portion and two relatively broader end portions. This problem happened due to insufficient concentration of heat energy around the two end portions of the weld pass. The uneven  
5 penetration may result in curving of the stainless steel parts during cooling. Further, when examined the outer appearance, spatters are seen around the weld pass, and a further complicated surface finishing processing process will be necessary.

## **SUMMARY OF THE INVENTION**

The present invention has been accomplished under the circumstances in  
10 view. It is the main object of the present invention to provide a welding flux for use in welding stainless steel parts, which greatly increases welding penetration. It is another object of the present invention to provide a welding flux for use in welding stainless steel parts, which keeps a good outer looking at the weld. It is still another object of the present invention to provide a welding flux for use in welding stainless steel parts,  
15 which keeps the cross section of the weld pass in an equal width. It is still another object of the present invention to provide a welding flux for use in welding stainless steel parts, which improves the welding efficiency of stainless steel parts over 3mm thick.

To achieve these and other objects of the present invention, the welding flux  
20 for use in welding stainless steel parts to increase welding penetration, is comprised of essentially a base material obtained from manganese peroxide ( $\text{MnO}_2$ ), and an activator selected from a material group that includes zinc oxide ( $\text{ZnO}$ ), silicon dioxide ( $\text{SiO}_2$ ), chromium oxide ( $\text{CrO}_2$ ), titanium dioxide ( $\text{TiO}_2$ ), molybdenum dioxide ( $\text{MoO}_2$ ), and iron oxide ( $\text{Fe}_2\text{O}_2$ ). The method of joining two stainless steel members includes the  
25 steps of: a) mixing a welding flux prepared subject to claim 1 in a liquid carrier to form

a paste-like flux, applying a thin layer of said paste-like flux over the joint of the stainless steel members, and welding the stainless steel members together using an arc welding torch.

#### **DETAILED DESCRIPTION OF THE INVENTION**

5           A welding flux for use in welding stainless steel in accordance with the first embodiment of the present invention consists essentially of manganese peroxide ( $\text{MnO}_2$ ) and zinc oxide ( $\text{ZnO}$ ). Both manganese peroxide ( $\text{MnO}_2$ ) and zinc oxide ( $\text{ZnO}$ ) have the particle size #325. Manganese peroxide ( $\text{MnO}_2$ ) is the base material that takes about 80wt% of the welding flux. Zinc oxide ( $\text{ZnO}$ ) is an activator that takes about  
10 20wt% of the welding flux. The mixture of manganese peroxide ( $\text{MnO}_2$ ) and zinc oxide ( $\text{ZnO}$ ) thus obtained is added with a suitable amount of liquid carrier, for example, acetone that makes the mixture into a paste-like status. In an application example of the welding flux according to the first embodiment of the present invention, a flat brush was used to evenly apply the paste-like welding flux to the surface of the  
15 5mm thick 304 stainless steel butt joint to be welded over the welding arc-welding area. The total width of the applied welding flux was about 10mm. The applied thickness of the paste-like welding flux was sufficient to mask the metal surface luster of the stainless steel. The arc-welding operation was started immediately after acetone had been completely changed into vapor.

20           Inert gas tungsten arc-welding (TIG) was performed on the aforesaid stainless steel parts with current 125A and travel speed 75mm/min. After welding, no significant spatter was seen around the welding path, and the surface of the welding path was almost in flush with the surface of the surrounding area without welding, and therefore a smooth outer appearance was obtained. When examined the cross section  
25 of the welding path (the direction perpendicular to the welding thickness of the

stainless steel parts), the welding path exhibited a narrow weld pass of equal width of complete penetration in the 5mm thick stainless steel parts.

In the aforesaid first embodiment of the present invention, the particle size of manganese peroxide ( $\text{MnO}_2$ ) and zinc oxide ( $\text{ZnO}$ ) is #325. A relatively greater  
5 particle size may result in poor bonding effect of the welding flux to stainless steel parts. Further, water, or volatile material such as methano or alcohol may be used as a liquid carrier to substitute for acetone. Other activator such as silicon dioxide ( $\text{SiO}_2$ ), chromium oxide ( $\text{CrO}_2$ ), titanium dioxide ( $\text{TiO}_2$ ), molybdenum dioxide ( $\text{MoO}_2$ ), iron oxide ( $\text{Fe}_2\text{O}_2$ ) may be used to substitute for zinc oxide ( $\text{ZnO}$ ). However, the use of zinc  
10 oxide in the welding flux according to the first embodiment of the present invention shows the best effect in flushness between the surface of the welding path and the surface of the surrounding area without welding. Further, the content of manganese peroxide ( $\text{MnO}_2$ ) in the welding flux within 70wt%~90wt% shows a relatively better effect. Most preferably, manganese peroxide ( $\text{MnO}_2$ ) is about 80wt% in the welding  
15 flux.

A welding flux for use in welding stainless steel in accordance with the second embodiment of the present invention consists essentially of manganese peroxide ( $\text{MnO}_2$ ), zinc oxide ( $\text{ZnO}$ ), and silicon dioxide ( $\text{SiO}_2$ ). Manganese peroxide ( $\text{MnO}_2$ ), zinc oxide ( $\text{ZnO}$ ) and silicon dioxide ( $\text{SiO}_2$ ) have the particle size #325.  
20 Manganese peroxide ( $\text{MnO}_2$ ) is the base material that takes about 70wt% of the welding flux. Zinc oxide ( $\text{ZnO}$ ) and silicon dioxide ( $\text{SiO}_2$ ) are activators that take about 20wt% and 10wt% of the welding flux respectively. The mixture of manganese peroxide ( $\text{MnO}_2$ ), zinc oxide ( $\text{ZnO}$ ) and silicon dioxide ( $\text{SiO}_2$ ) thus obtained is added with a suitable amount of liquid carrier, for example, alcohol that makes the mixture  
25 into a paste-like status. In an application example of the welding flux according to the

second embodiment of the present invention, a flat brush was used to evenly apply the paste-like welding flux to the surface of a 5mm thick 316 stainless steel T joint over the welding arc-welding area. Inert gas tungsten arc-welding (TIG) was performed on the stainless steel parts with current 125A and travel speed 75mm/min. After welding,  
5 no significant spatter was seen around the welding path. When examined the cross section of the welding path (the direction perpendicular to the welding thickness of the stainless steel parts), the welding path exhibited a narrow weld pass of complete penetration in the 5mm thick stainless steel parts.

The main features of the present invention are as follows:

10 1. The welding flux causes contraction of arc beam to effectively concentrate arc energy, thereby increasing the dept of penetration of the weld.

2. The welding flux causes contraction of molten cavity, thereby increasing current density at anode spot to further form a narrow and deep cross section of weld pass.

15 3. The cross section of the weld pass formed by using the welding flux shows an even width, preventing curving of stainless parts during cooling.

4. Because the well pass formed by using the welding flux has an even and deep cross section and smooth outer appearance without spatter, the invention saves much pre-welding (for example, making a V-groove) and post-welding processing  
20 time (for example, performing weld pass appearance processing process), thereby increasing the production efficiency and reducing the manufacturing cost.

In addition to inert gas tungsten arc-welding (TIG), the invention is practical for use in other inert gas metal arc-welding, carbon arc-welding (CAW), submerged arc-welding (SAW), and flux cored arc-welding (FCAW). Further, in addition to the  
25 method of directly applying the welding flux to the surface of the joint, the welding

flux can be applied to the workpiece by one of the following methods as: adding a foaming agent to the welding flux to form a foam-like welding flux for enabling the foam-like welding flux to be applied to the joint to weld by means of a pressure apparatus; gathering the welding flux at the joint to weld by means of a static effect; 5 coating the welding flux on a thin-film base material and then adhering the thin-film base material to the joint to weld.